Managing the complexity of environmental assessments of complex industrial systems with a Lean 6 Sigma approach

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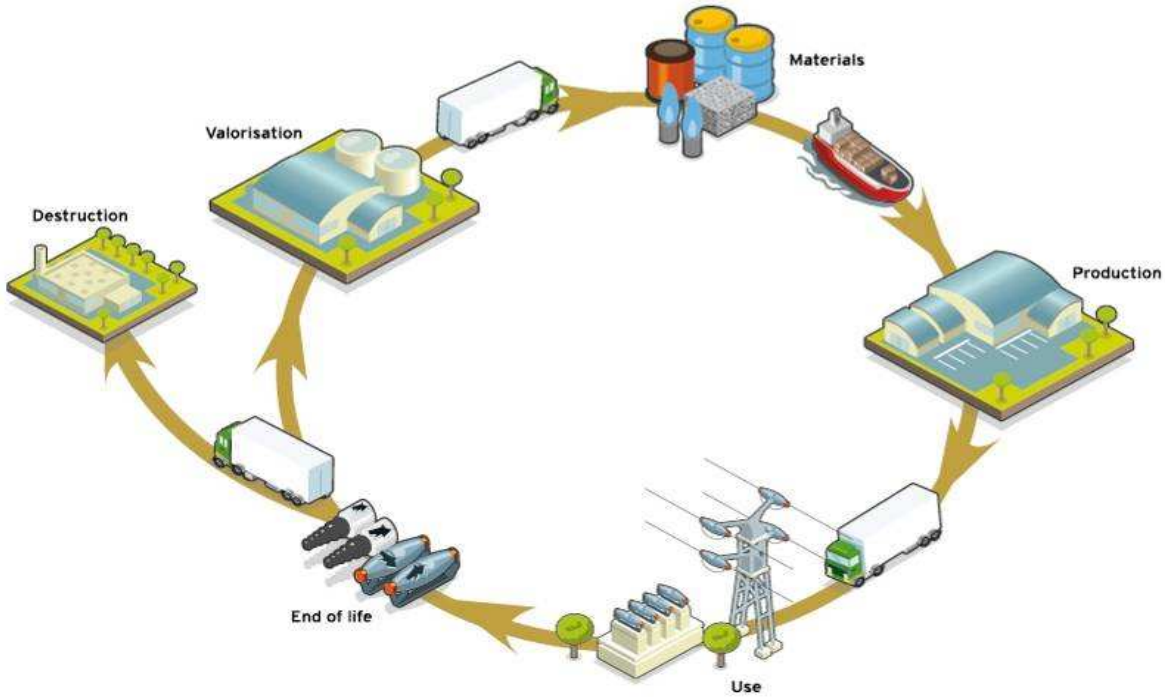
Introduction

Eco-design has become a major concern for many companies

Eco-design: The integration of **environmental requirements** into the **product design** or improvement process, along with **other design parameters** (technical feasibility, cost, quality, etc.), in order to **improve its environmental performance** throughout the product **life cycle**. The product concept includes goods, services and processes. (Areva 2006)



B to B firms now feel concerned

But the classical eco-design process seems to be not adapted to complex industrial systems

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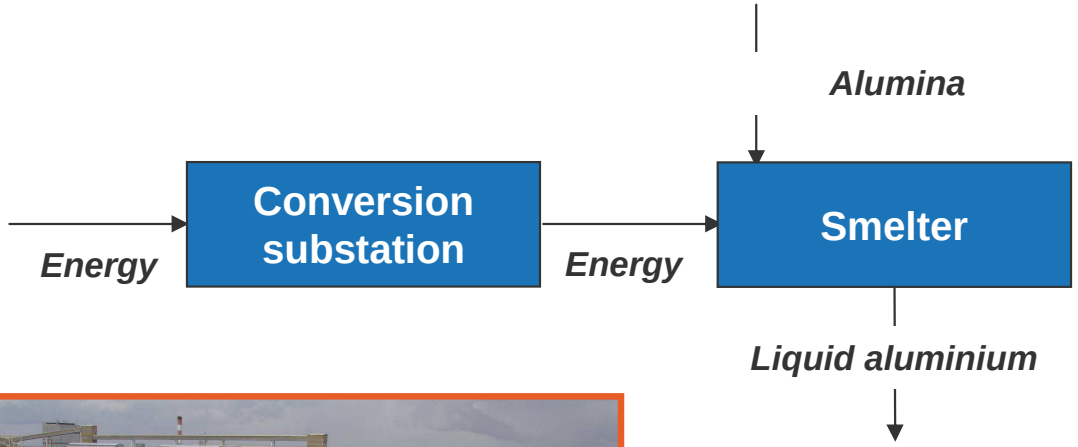
Aluminium smelters & conversion substations: complex industrial systems

- High number of **subsystems** and components
- **Operation** phase very **uncertain**
- **End-of-life** almost **unknown**
- Closely linked to the **macro-system** (aluminium smelter)
- Environment is a priority for aluminium producer but they are **not able to eco-design the whole system**



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Eco-design & complex industrial systems

A classical eco-design process

Life Cycle Assessment [ISO 14040]

This process encounters **limits** face to complex industrial systems

- Boundary selection [Reap *et al.* 2008]
- Multi-functional processes [Reap *et al.* 2008]
- Data granularity, availability and quality [Leroy 2009]
- Spatial and temporal dimensions [Reap *et al.* 2008]
- Economic and political dimensions
- Team, milestones, stages ?

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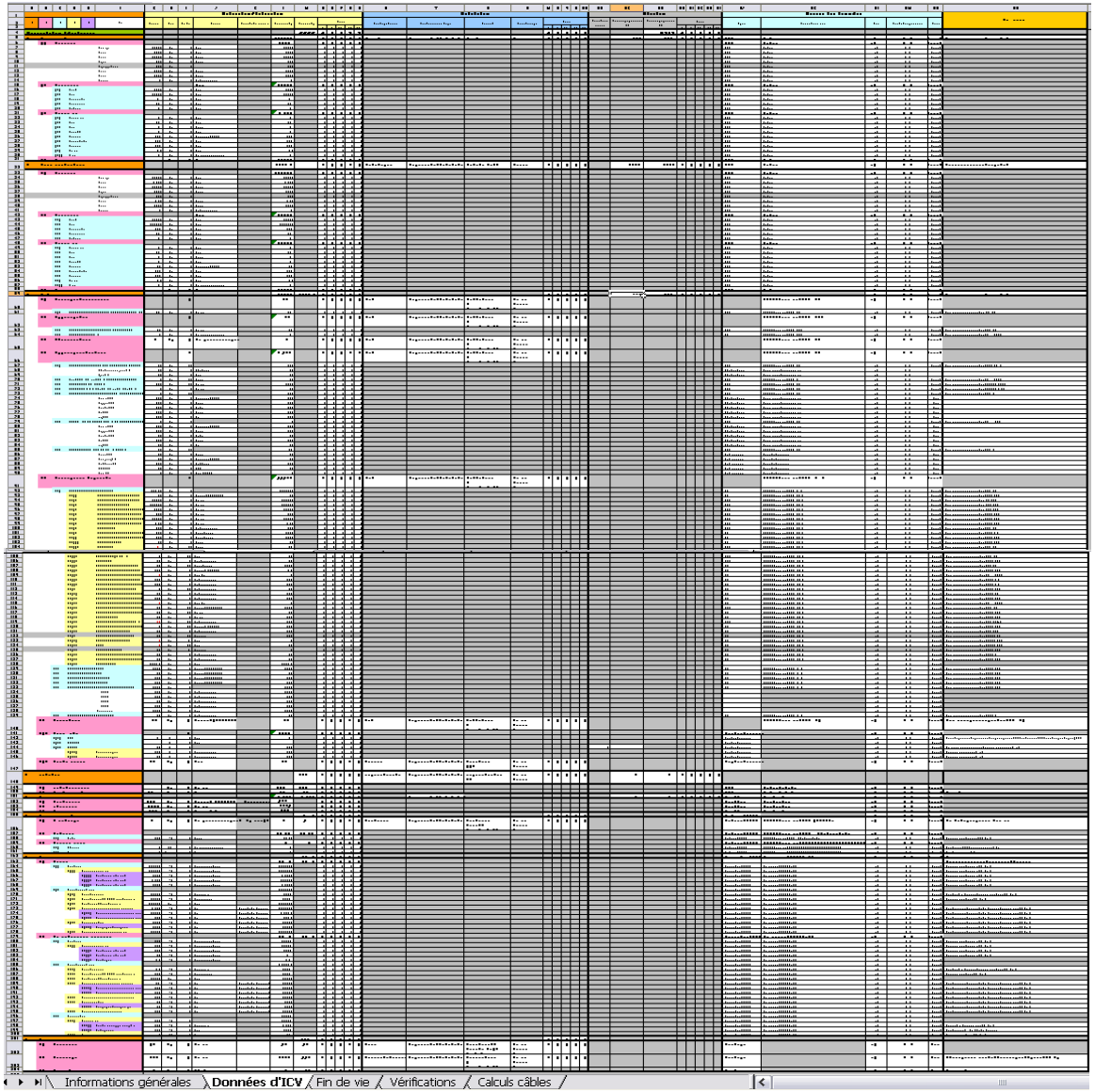
Complexity of environmental assessments of complex industrial systems

Example of a simplified LCA of a conversion substation (6 months)

We encounter limits in terms of:

- Data **quality**
- Data **availability**
- Choice of the **level of detail**



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Methodology requirements

We need to define a methodology that:

- Is able to systematically consider the **technical LCA limits** concerning complex industrial systems,
- Can be declined on different **systems and subsystems** levels,
- Considers a **reference product** to improve,
- Supports **ISO standards** about LCA,
- Covers both the environmental **evaluation and improvement** phases,
- Offers a **rigorous framework** with precise milestones and deliverables,
- Is able to take into account **customer requirements**.

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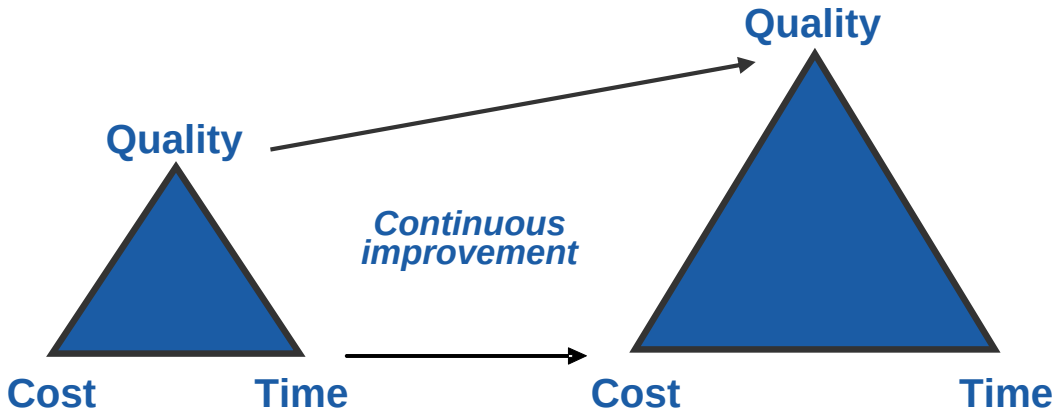
Lean 6 Sigma & Lean and Green

The LSS offers a rigorous framework that matches some of our requirements

- It creates **values** for the stakeholders
- It gives **competitive advantages**



- The ***Lean & Green*** field
  - Mixes LSS and environmental considerations
  - To improve the environmental performance
  - Examples : IBM Green sigma [Olson 2010], US EPA toolkits [USA EPA 2007]…
- But the existing approach **are not product-oriented**

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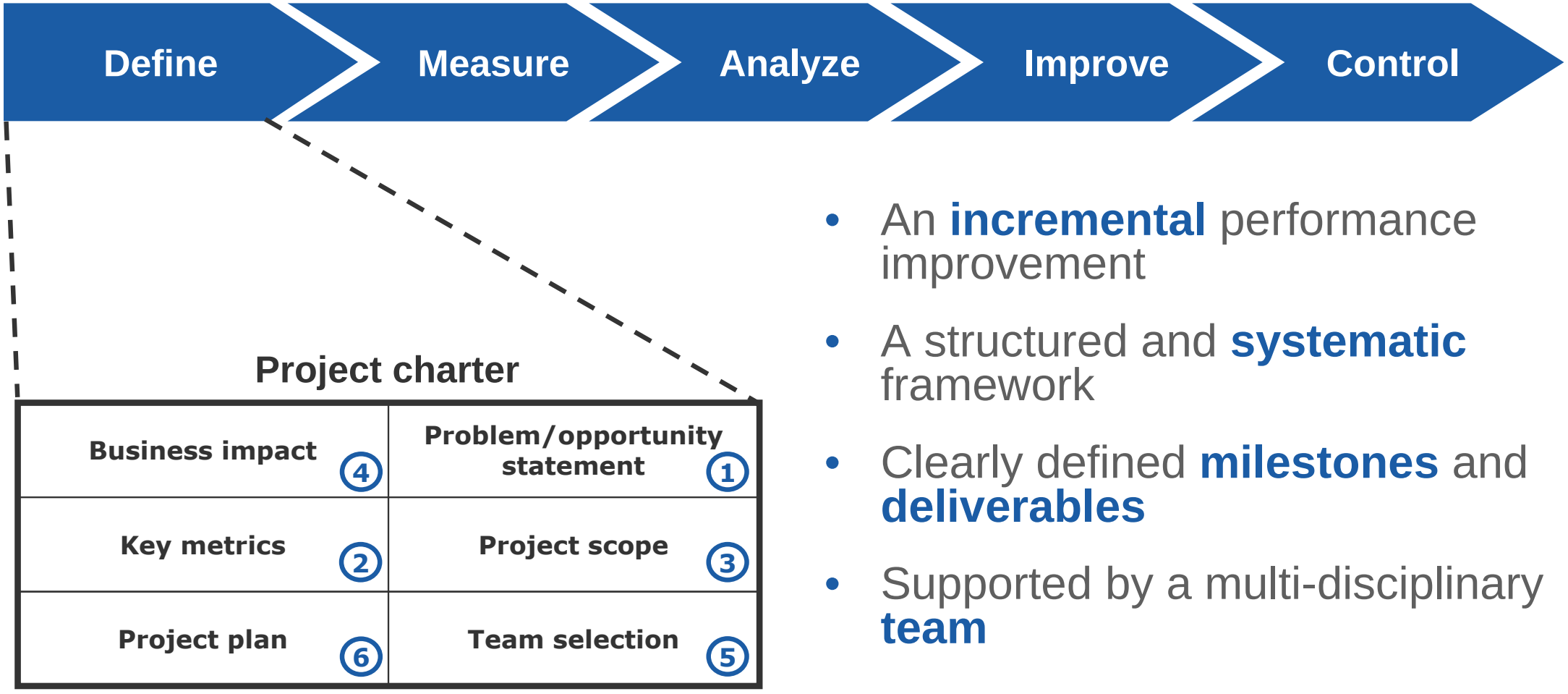
The DMAIC approach

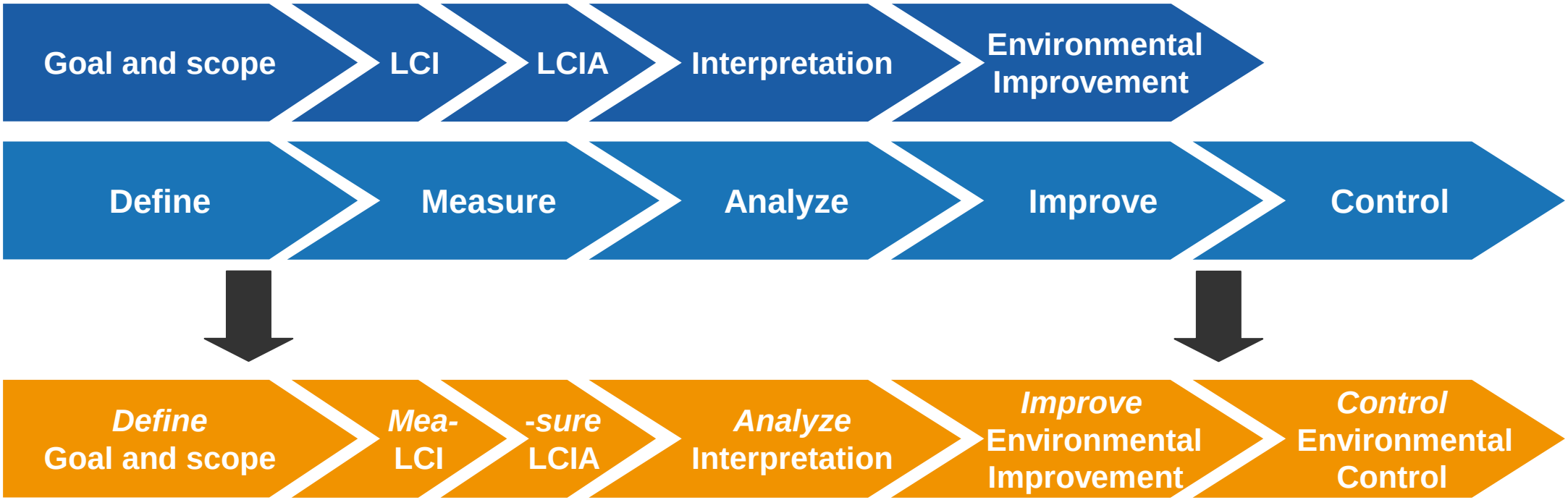
The DMAIC approach is adapted to complex problems



- An **incremental** performance improvement
- A structured and **systematic** framework
- Clearly defined **milestones** and **deliverables**
- Supported by a multi-disciplinary **team**

Proposition of a methodology

Management of eco-design projects of complex industrial systems based on a DMAIC approach



But this approach is **hardly applicable** on complex industrial systems as is

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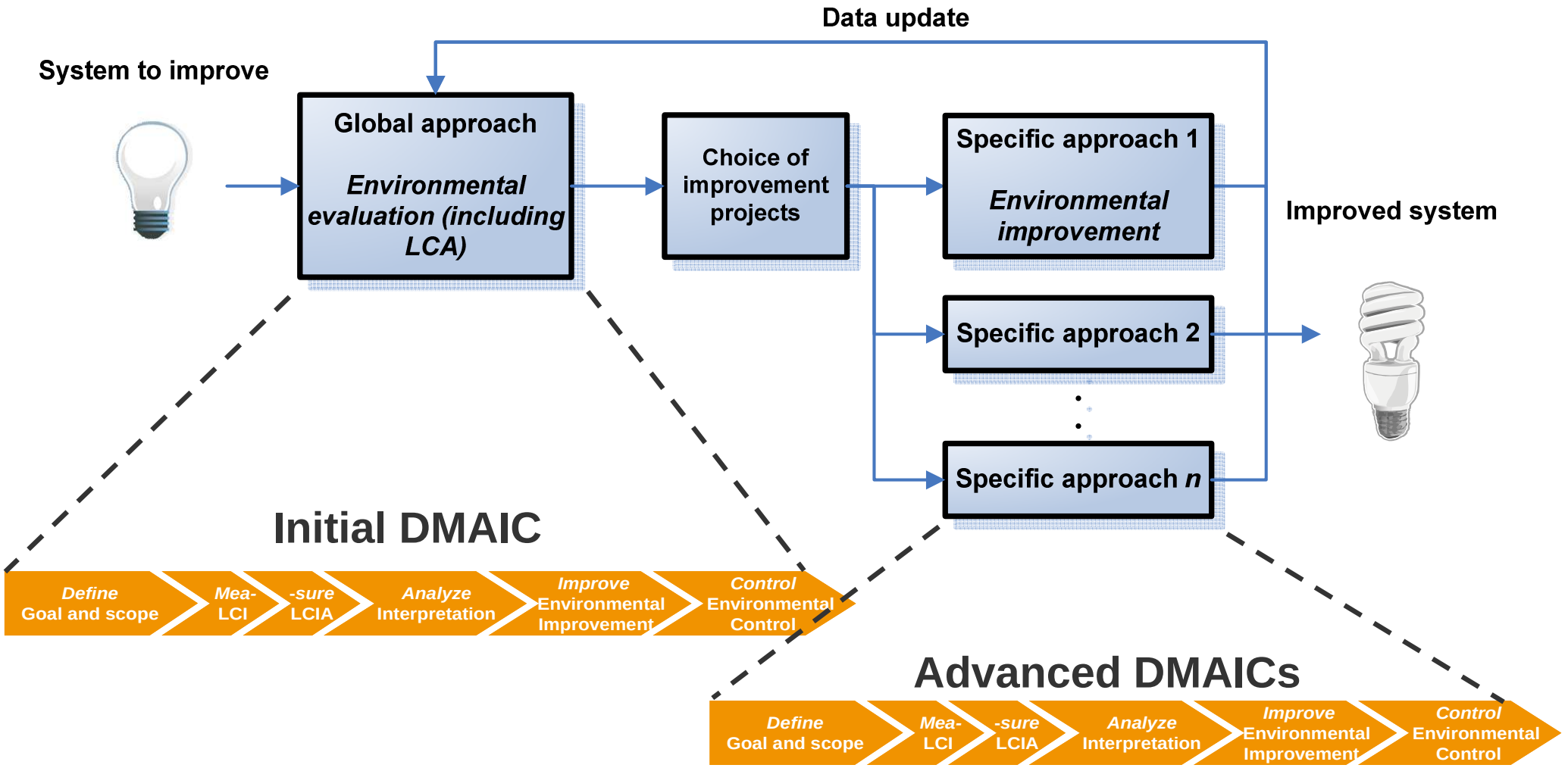
Evolution of the methodology

The global approach feeds the specific approaches



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Application on Alstom Grid conversion susbstations

Define
- Project charter including LCA goals and scope
- Customer requirements identification

Measure
- Life Cycle Inventory
- Life Cycle Impact Assessment
- Data management procedure

Analyze
- LCA report

Improve
- **Setting up of an internal working group (in progress)**
- Use of eco-innovation creativity tools
- Identification of environmental improvement ways

Control
- Standardization, documentation
- Communication (internal and external)
- Choice of environmental improvement ways to carry out by the project sponsors in advanced DMAICs

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Advantages of the methodology

- The methodology supports the **eco-design of complex industrial systems**.
- It is **in accordance with the LCA ISO standards** [ISO 14040] [ISO 14044]. The results are transmissible.
- The **project team** is clearly defined, as well as **milestones** and **deliverables**. The methodology is **reproducible** and standardized.
- It takes into account the **customer requirements**.
- It is adaptable to the **company requirements** in terms of level of details.
- It is based on a **well-known continuous improvement method**.

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Perspectives

To enhance the reliability of the methodology

- By defining **metrics** to measure the methodology performance
- By **applying** it on other complex industrial systems
- By inserting it in the **ISO standards** framework (ISO 14006 in particular) [ISO 14006]
- The **life cycle modelling** in LCA will be studied to improve the results reliability in a specific context
  - Uncertain life time
  - Maintenance
  - Obsolescence
  - Political and economic context
- Towards the design of **“eco-designing organisations”**?

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Thank you for your attention!

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